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An
Inaugural Dissertation
on the formation of
Bone
and the
Physiology of the Skeleton

by

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An Inaugural Dissertation on the formation of Bone, and the Physiology of the Skeleton.

The object of the following Essay is to present a consistent view of the Formation of bone, and physiology of the ~~Osseous system~~ Skeleton, and more particularly to Notice the views which have been recently suggested by professor Physick in relation to this Subject.

That a knowledge of the structure, actions and functions of a part are an essential requisite to a surgeon, is incontestable: without this knowledge, his practice must be confined to the narrow limits of observation alone, and being ignorant of those operations which it is his business to assist, much uncertainty and empiricism must necessarily follow. There appears to exist an uniformity of

structure not only in similar bones in the same [illegible] species, but also in animals in whom the bones, in their external characters corresponds; so that the general remarks in this paper are equally applicable to comparative anatomy; so far at least as my observations have extended.

As introductary to the subject it may be proper to investigate the facts afforded us by Chemical analysis, as it will facilitate the elucidation of many facts connected with the formation and growth of bone; and also the changes incident to many morbid affections, together with the practical inferences drawn from these facts.

Although the bones entering into the composition of the skeleton exhibit innumerable varieties in their structure, form and position, they are upon

chemical analysis reducible to the same constituent principles and consists of earthy and animal substances intimately connected and blended together, in such a manner as to form a substance of a white colour, & whose characteristic property is firmness. These may be disunited and exhibited separately. The animal part may be separated from the earthy by calcination, and the earthy part thus exhibited is very porous, retaining the form of the bone, and is composed principally of the Phosphate & Carbonate of Lime; to which may be added Phosphate of Magnesia, a small portion of the Sulphate of Lime and about three per ct. of the Fluate of Lime.

To obtain the animal part it is necessary to immerse the bone in an acid liquor capable of dissolving the earthy matter, without acting upon the animal part;

the muriatic acid is generally used for this purpose, and is poſseſsed of the property of diſsolving the earthy salts, together with the gelatin, and the soft elastick substance that remains undiſsolved, retaining the original shape of the bone, resembles in its Chemical properties Coagulated albumen.

The relative proportion ~~that~~ of the earthy salts ~~bear~~ to the animal part is materially influenced by the age of the individual; it likewise varies according to the nature of the bone, and the purposes which it is destined to serve in the animal economy. At puberty ~~the~~ ~~quantity of~~ these two Substances are nearly equal in the generality of bones. In the teeth the quantity of earthy matter predominates, and the enamel is wholly composed of the earthy substance, which

is rendered neceſsary from its exposed situation. In some diseases the earthy salts are absorbed into the system, and the cartilaginous basis predominates: when this occurs in infancy a disease is produced termed Rickets; a similar complaint occuring in advanced life, is designated by the term Mollities Oſsium. This knowledge of the chemical history of bone, as Stated on a former occasion, is very useful in tracing the formation and growth of bone; as also the changes produced by certain Morbid affections; but whether it is calculated to facilitate in any Considerable degree our practical knowledge is exceedingly problematical. Although this aſsertion is generally admitted at the present day, there was a period when substances where exhibited in the diseases noticed above, which in their chemical properties corresponded with the earthy salts of bone, with a supposition

that they would be carried by the bloodvessels, and deposited in the parts where this deficiency existed. These erroneous opinions, which were sanctioned by the highest authorities, produced a practice equally absurd and injudicious, and which is now happily exploded.

Thus constructed the bones divested of the soft parts compose a Skeleton; and are calculated from their firmness to give stability to the system, and afford a firm basis for the body; to protect many important parts as the brain, the contents of the Thorax, etc. from the injuries arising from the action of external forces. 3^{dly} They afford attachment to muscles, and form levers, which are put in motion by muscular contraction - and in this manner locomotion is effected. - in addition to this, it gives symmetry and elegance to the body, the

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size of which is regulated by this System.

Having noticed the facts afforded by Chemical analysis, we shall proceed to shew that the bones are like the soft parts poſseſsed of blood-veſsels, nerves and lymphatic veſsels.

The existance of blood-veſsels are proven directly and indirectly. If for instance an animal be nourished with food, mixed with madder, the bones will ~~acquire~~ aſsume a red colour, which is evidently derived from this substance. They are also proved directly by injecting the bone. These veſsels are transmitted to the bone by a membrane which covers its external surface, denominated periosteum, which will be more particularly noticed hereafter: the bones also receive veſsels by foramina which penetrate the substance of the bone.

In a natural state the bones poſseſs but little sensibility, but when inflamed they

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are very sensible which proves the presence of nerves –

The existence of absorbent veſsels ~~are~~ is equally certain with the blood veſsels, although they cannot be demonstrated except by their effects, but these are too obvious to admit of doubt.

The bones constructed in this manner, are poſseſsed of an innate power of repairing injuries received; and in some instances this power of reparation is exerted in a surprising degree; as is strikingly exemplified in Necrosis, a disease which is similar to mortification of the soft parts of the body, ~~in~~ where the Sequestra is thrown off and a reproduction of bone is effected –

This is said to be analogous to the mortification of the soft parts of the body, but it differs materially from it, for in Necrosis the periosteum, which is supposed to serve the same office to bone as the integuments do for the so

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soft parts, separates and is the agent concerned in the reproduction of the bone; whereas in Mortification of the soft part, the integuments are removed, this shews the impropriety of assimilating these two processes.

As the recuperative powers of a part are proportioned to its vascularity, it is obvious that this power must be feebly exerted in bone. It is on this principle we explain the reason ~~why~~ a fractured bone requires twenty days, and not unfrequently two or three months, when a solution in the continuity of a soft part, if brought into apposition, heals in two or three days — (Vide Boyer on the Bones) —
The vascularity of bone varies according to the age of the individual; in infancy it is greatest and consequently its vital energies are most considerable at this period; as the animal increases in years, this power

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The membranous covering of bone is denominated Periosteum, its firmness is considerable; and a fibrous and laminated structure is very perceptible; it adheres firmly to the bone by the intervention of fibres, blood-vessels, lymphatics, etc. The periosteum covers all the external surface of bone, except those parts forming the articulations, the surfaces occupied by the insertion of tendons, ligaments &c, ~~and~~ the body of the teeth and internal surface of the cranium. The functions of the periosteum are performed on the internal surface of the cranium by the dura mater. The external surface of the cranium is supplied with a membrane similar in every respect to the periosteum denominated Pericranium –

The periosteum serves a threefold purpose in the animal economy. 1st It trans-

-mits blood-veſsels etc. to the bone. 2dly It circumscribes the bone, preventing the diseases of the soft parts from being propagated to the bone, hence when an abceſs forms in the soft parts, contiguous to the surface of the periosteum, it thickens and the disease is excluded from the bone. 3dly It is rendered probable from the observations of Boyce and other writers on the subject that the periosteum reproduces the bone in cases of Necrosis. This is rendered probable by a fact that in parts which are destitute of this membrane a reproduction of bone does not take place; as for example in the teeth; when a portion of the cranium is removed in the adult a reproduction of bone does not take place in consequence of the pericranium being removed with the bone, it is probable from this circumstance that the functions of the dura mater are limited in this particular - The importance of the

periosteum is certainly considerable, as it exists at every period of life.

Bones have a fibrous and laminated structure, the former is proved by calcination and is obvious in the bones of the head, and the long bones, as the femoris and Tibia may be separated into laminæ —

Bones differ in their form, and a corresponding difference is observable in their structure. For the convenience of description they may be divided into the cylindrical & flat. The flat bones are composed of two plates of firm bone, between which a spongy or reticular substance is interposed, technically termed diploë —

The degree of solidity varies in different bones and this diversity of structure is also observable in different parts of the same bone. The varieties, however, are reducible to two. viz. the compact and spongy. The structure of some bones are uniformly spongy as carpal bones, the tarsus,

vertebræ, Sternum, etc. In the long bones, as the femur and tibia, the spongy structure is confined to the extremities, which are larger than the middle portion, where the particles of bone are more solid and firm, having a cavity in the centre, in which is situated the marrow. Several advantages result from this arrangement. 1st By being larger at the extremities the opposing surfaces forming the joints are more extensive, by which the joints are rendered stronger. This enlargement is not attended with an augmentation of weight, for it has been ascertained by professor Physick that an inch of bone taken from the extremity of the femur has the same weight as an inch taken from the middle portion, although the former occupies the greater bulk. The bones are leſs liable to fracture near the extremities, this is not the least important use, for fractures are stated to be dangerous in proportion to

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to its vicinity to the joint. It is Stated that towards the middle the Structure is more firm, having a central cavity in which the marrow is situated. This central cavity renders the bone much stronger. It is a principle in mechanics that hollow cylinders are stronger than those that are solid; and on this account the bones are not only stronger but also lighter by this arrangement. The marrow that is contained in the cancelli of bones is of an unctious nature, and in herbaceous animals, it is said to harden when it becomes cold: but it remains fluid in Carnivorous animals. In young subject it is more fluid, and is tinged of a red colour. The marrow is contained in cells and enclosed by a membrane called periostium internum. Various uses have been aſsigned to the marrow, some authors supposed it was to prevent the bone becoming brittle; others supposed its use was to fill up the void, and in this manner to prevent the preſsure of the atmosphere from crushing

their parieties. (Vide Rees' Cyclopædia article Bone) Dr Rees observes "there is no matter in the animal economy more suitable to fill their spaces than the marrow; and it is to be regarded as a part of the adipose system of the animal. In corroboration of this remark it has been observed that in impoverished and dropsical subjects where there is no fat in other parts, there is likewise none in the bones." May not the marrow be useful in effecting a change in the blood preparatory to its conversion into bone? In confirmation of this, we may state, its great vascularity in infancy. —

The use of the spongy structure is "to prevent the force of percussion from being propagated to remote parts of the body" This important fact was first suggested by professor Physick, who has proven it by a very ingenious experiment. —

The apparatus consists, simply of a board from which five balls of solid bone are suspended; three of the balls are connected together, and the two exterior are in contact with the others, but not connected with them; upon one of the exterior balls, being removed to a given distance, and allowed to strike the others, the force is extended through the three balls to the fourth, which being unconnected, is forced to a distance which is nearly equal to that which the first ball was removed: but, when a substance of a spongy nature is interposed between the balls that are connected together, and the experiment is repeated, the force of the blow being expended in the reticular substance, the exterior ball retains nearly the same position that it was in before the experiment.

The above experiment is intended particularly

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to exemplify the effects of blows upon the Cranium, and to shew the power of the reticular Substance, in preventing the force of blows from affecting the Substance of the brain. The above remarks are also applicable to the Spongy Substance existing in other parts of the Skeleton.

For the above experiment and many of the preceeding observations I acknowledge myself indebted to professor Physick's Lectures, whose important discoveries ~~has~~ have rendered this Subject, that is proverbially "dry" one of the most interesting and pleasing in this department of Medical Science. My acknowledgements are also due to the professor in the Surgical department, whose Suavity of manners and Spirited exertions will ever be remembered with gratitude by the Students generally: permit me, Sir, as an individual

to expreſs the many obligations we owe to you, and rest aſsured that we shall be ever emulous in meriting your regard —

I shall now proceed to make a few general remarks on the formation of Bone. This is a subject peculiarly interesting, as shewing the powers of the animal economy in a very striking light: in this proceſs we observe the blood, a homogeneous fluid, gradually aſsimilated into a substance that in stability and firmneſs exceeds every other part in the system. If we except the flat bones and the teeth, most others are formed in cartilage. The first chāge observable is an enlargement in the veſsels of the part, after which the earthy matter is deposited, as oſsification progreſses the bone gradually aſsumes the shape of the cartilage in which it was originally formed;

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the cartilage, that affords a nidus for the deposition of the ossious matter is gradually removed by the absorbing vessels. In flat bones the earthy matter is deposited like two plates, one above the other, that gradually extends and unites at their edges, leaving a space between them, which is occupied by the reticular substance. In each plate there are one or more centres of ossification, from which the fibres extend like radii from the centre. The time requisite for effecting this Change varies in different bones, Some, as the for example, the small bones of the ear are completely formed at birth; in others the progress of ossification is very rapid as the Clavicle, teeth &c. The generality of bones are not Completely formed, until puberty at which period the ejection and absorption being equal, Counterbalance each other

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Having concluded my observations on this Subject, it is with diffidence I submit them to your examination, and lay claim to a distinction, which I flatter myself I am not wholly undeserving of, and which is the privilege of your honourable body to confer ——

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